Manual and analytical assessment of piling

Dr. Mark Bohan, Eric Cathie and Lindsay Ferrari

Keywords: Piling, web press, blankets

Abstract

Piling problems can occur in many lithographic printing applications. It involves the build up of material on the blanket surface which leads to unacceptable print quality. The aim of this work program has been to understand the performance of a heat set web offset press with respect to piling to allow subsequent optimization. Earlier work [1] reported on the effect of process consumables on the degree of piling measured using profilometry.

The measurement of piling using profilometry was focused on selected areas within the image. These were areas that there was a transition from image to non image area where a step feature could be measured. There were a minimum of forty eight measurements carried out for each trial. These were then converted into a step height in microns.

The piling was quantified using manual assessment of the blanket surface. This was carried out by a single press operator in all forty eight trials that were completed. The assessment covered the whole blanket surface and included assessment for image, non-image and downstream piling. The piling was quantified on all four units using this method.

The results from the manual assessment are presented for the impact of each of the variable assessed, namely paper, blankets, ink, and fountain solution. The results show that these can have a significant impact on the level of piling.

This paper then focuses on comparing the piling measured by these two techniques. One is an analytical method that is much localized in its operation while the manual assessment provides an overview of the whole blanket surface. These comparisons show that there can be significant differences dependent on the measurement method used. These differences are discussed in detail with

PIA/GATF
Printing Industries of America / Graphic Arts Technical Foundation

respect to the actual application and explanations are provided as to the best technique with which to quantify the level of piling on the blanket surface.

Introduction

Piling, as defined as a build up of unwanted material on the surface of a lithographic blanket, is a significant problem for many web offset printers. This will impact the productivity of the press and the quality of the printed product. The purpose of this paper is to examine in greater detail some of the factors that give rise to piling in a commercial heat set web printing operation and evaluates the different types of piling assessment.

The increase in the number of blanket washes required to maintain print quality, time to change blankets and also the increased frequency of blanket washing equipment are some of the productivity issues. In certain instances, the piling may give rise to increased web breaks, dependent on the severity of the piling. These will also increase the amount of waste that is generated with each print job. The quality of the product may also be degraded with changes to the solid print area, the halftones and scumming in the non image area.

Piling is a complex transfer that can be affected by many of the dynamics of the nip contact at both the substrate / blanket and blanket / plate contact points. There are many factors that can affect the level of piling on a print production job and some of these are shown in Figure 1. There are many interactions occurring between the different factors and as these are changed the level of piling can also change.

Some factors affecting piling

Fountain solution	Substrate	Ink	Process	Consumables
pH	Porosity	Ink emulsification	Mechanical properties	Plate
Conductivity	Absorbency	Ink drier	Printing units	•Screening
VOC	Moisture content	Tack	Mechanical design	•Grains
Additives	Smoothness	Viscosity	Packing	•Variation in sensitivity
Fountains solution	Roughness	Elasticity	Impression	•Ink holding & transferability
Dosage	Elasticity	Colour sequence	Print sequence	Blankets
Quantity	Compressibility	Varnish	Humidity	•Roughness
	Thickness	Pigments	Speed	•Surface energy
	pH	Additives	Drying temperature	•Deformation
	Uniformity		Roller composition	•Compressibility
	Cleanliness		Nip	
	Surface energy			

Figure 1: Factors that may affect piling.

There are different forms of piling that can occur, the mechanisms that drive them can alter and the impact of different variables on the propensity of each to be formed will alter. There are three main types of piling that can be characterized by their position on the blanket. These are referred to as image, non-image and downstream piling. Image piling normally manifests itself on the trailing edge of the print and can be identified by missing sections in the printed product. Non-image piling is a build-up of material in the non-image areas of the print, either in low tonal coverage's or in complete non image area. Different mechanisms drive this formation and in the tonal areas can give rise to a mottled effect. Downstream piling is the build-up of ink and material on subsequent units after printing. This is when the transfer is preferential to the blanket surface rather than the paper.

This paper briefly describes the experimental design used to carry out the evaluation, including the trial protocol and a discussion of the two measurement techniques. This is followed by a detailed discussion on the results obtained from the two techniques.

Experimental procedure

The objective of the investigation was to evaluate the impact of paper (3 levels), blankets (4 levels), fountain solution (4 levels), and ink (4 levels) on the propensity of a lithographic press to produce piling. These did not all vary continuously and were at discrete levels (i.e. they were all commercial products). A d-optimal experimental design technique was used and this reduced the number of experimental trials required by approximately 75%, to a final number of trials required to 50, including repeats. Further details of the experimental design and procedure can be found in [1].

To ensure repeatability, the same protocol for each of the press trials was set. This included the pre-trial warm up, each experimental run, and the post trial evaluations. The press was warmed to ensure consistent temperature throughout the duration of the trials. This was confirmed by measurements on the units using temperature probes and a non contact pyrometer.

The image used for the evaluation is a split test form having a 25 micron stochastic screening on one half and a 150 lpi conventional screen on the other, shown in Figure 2. The same image was used on the upper and lower units of the press. The measurement areas used for the profilometry are highlighted, the manual assessment was carried out across the whole of the test form area. The solid bands in the center section were to help differentiate the two screening methods while printing and to help with the water supply.

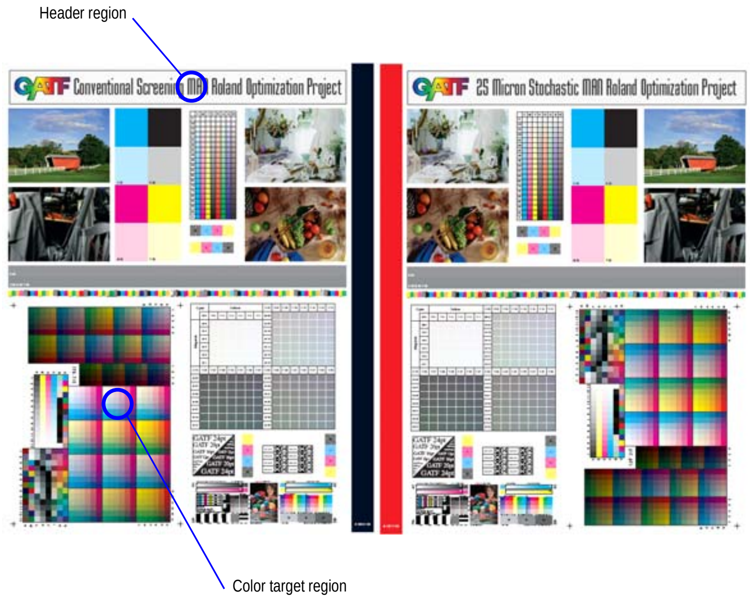

Figure 2: Image used for the trial

To ensure a fair comparison between the stochastic and conventional screening, the color balance needed to be adjusted as the two screenings types have very different tonal reproduction curves. A number of pre-trial tests were completed and the plate curves adjusted for the stochastic region to obtain a balanced image between the two screens. In this procedure the tonal reproduction was matched, as was the grey balance.

There are a number of different techniques available for the measurement of piling; those which were used during the program are listed below:

- Visual (photographs etc)
- Human (feel the blanket)
- Tape pulls
- Profilometry

The human evaluation of the piling was made by the same operator and each of these was referred back to a roughness reference gauge before these evaluations were recorded. The use of the roughness gauge ensured that there was consistency over time with the assessments made by the operator. This was confirmed by the repeat trials that were carried out as part of the experimental program. The operator assessed the piling across the whole of the width of the blanket and also around its circumference. This was achieved by feeling the surface texture and providing a feedback regarding the severity, an example of the assessment is shown in Figure 3. This technique allows the assessment across the whole of the blanket surface and it is not specific to a particular area.

Figure 3: Manual assessment carried out on press

The profilometry measurements were taken from the areas highlighted in Figure 2. This allowed the build up of material to be quantified numerically. Two measurement areas are discussed in the paper, those being in a light tonal header region and also in a color target at the transition between two tonal patches. These measurements were carried out for each of the screening areas on top of the unit, while for the bottom blanket of each unit measurements were made in the header region only for each screening. For each of the areas assessed two repeat measurements were made adjacent to each other. Any errors in measurements were immediately apparent in the trace obtained and in these cases further supplemental measurements were taken. These errors were normally due to movement of the profilometer while taking the measurement, positioning of the instrument not parallel to the blanket cylinder or a dirty probe tip. A typical measurement being carried out is shown in Figure 4.

Figure 4: Profilometry carried out on press

Results and discussion

The results will discuss initially the piling that has occurred on the blanket surface. This will be followed by a brief review of the piling that was measured using the profilometry, to be followed by a detailed discussion of the piling assessed manually by the operator. This will be compared to the profilometry results and the reasons for any discrepancies between the two methods are discussed.

The material properties were discussed in detail in an earlier paper, for details refer to [1]. All the materials used for the investigation were commercially available. Three papers were used for the trial and these covered a wide range of those used commercially, from a grade #2 to a grade #5 coated papers. Four ink sets were used having different rheology and chemistry. The four blankets used for the investigation had different surface and internal properties, with one of the blankets running approximately 5^0F warmer than the other three. The materials assessed were completed by the four fountain solutions with different VOC levels, as well as varying chemical compositions.

The piling assessed with the profilometry was discussed in detail in [1]. The piling on the black unit showed that the paper, ink and blankets all had a considerable effect on the degree of piling. There was a small impact caused by the fountain solution. There were also interactions between the different variables. Considering the subsequent units, the impact of the interactions became more significant with the introduction of downstream piling. There is also an increase in the level of piling. The largest measured piling occurs on the yellow unit, which is the last color printed. It should be noted that very low levels of piling were also measured on the yellow unit for certain combinations, with no piling in certain locations. Typical results from the yellow unit are shown in Figure 7 for the paper / blanket interaction in the upper header region Y1. The best performing paper was paper three, though there were two blankets that were completely insensitive to changes in the substrate type.

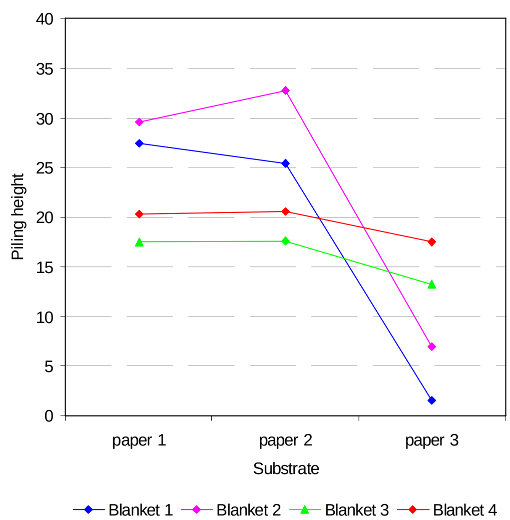

Figure 5: Profilometry piling levels for paper / blanket interaction for area Y1

The piling was formed across the whole blanket surface and certain measurement areas were used for the analysis. A typical example of the piling is shown in Figure 6. This shows the piling on different areas on the surface. In this particular case there is a build-up of material on the lead edge and also on the edges of the print form. The objective of the manual assessment was to characterize these levels of piling and identify the magnitude that each of the combinations produced. The operator was asked to assess all the areas in turn and produce a rating for each of the sections. The press was sub-divided by:

- Unit(black, cyan, magenta, yellow)
- Upper or lower
- Across the width (edges and center of the blanket)
- Around the circumference (lead edge and the main blanket surface)

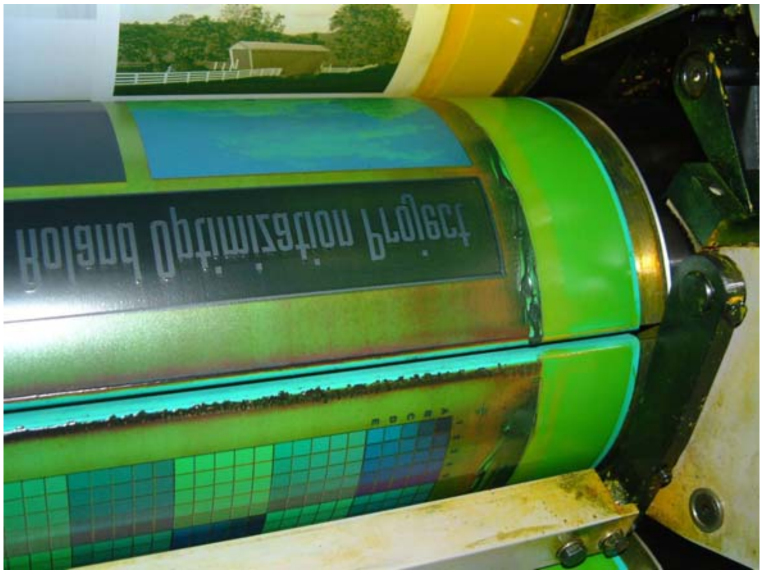

Figure 6: Example of piling on the blankets

The results from the manual assessment of piling were obtained by averaging all of the assessments across the surface of the blanket. The surfaces were ranked between 0 and 5, with the higher the number, the greater the piling that was on the blanket surface. This was carried out as there was not a tight correlation between the two assessment type's measurement areas, also the manual assessment included areas such as the edge of the blanket. The effect of the paper on the piling on the black unit was shown to be negligible. This was not the case with the profilometry with clear differences, dependent on the area being measured. In the header region the lowest piling was found with paper 3, while this had the highest piling in the color target region. The combination of these two areas, as made by the press operator, resulted in no appreciable impact of the paper. In addition to this, the piling on the black unit was low throughout the duration of the investigation, with the mean piling levels being under 20 microns. The low level of the piling on this unit made it difficult for the press operator to effectively differentiate between the different piling levels.

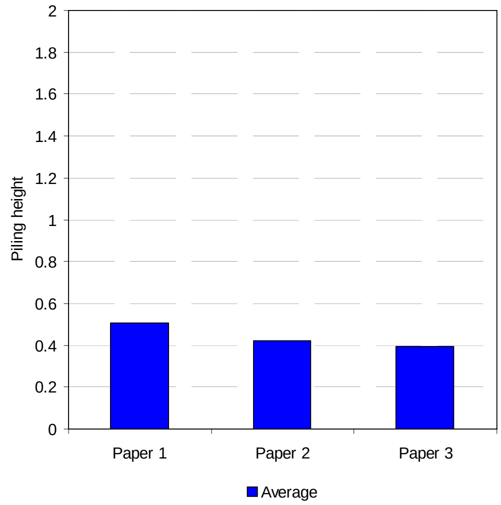

Figure 7: Manually assessed piling levels for paper for the black unit

The largest impact of the variables assessed on the black unit was found with the ink, Figure 8. The ranking given to each of the areas is relatively low, indicating the problems in identifying the piling on this unit. These showed that inks two and three performed with minimal piling. This is in general agreement with the results obtained form the profilometry, in which each of these inks performed with the lowest piling, dependent on the measurement area being assessed. The difference in the relative piling between the two piling assessment methods with ink four is larger in the profilometry and is most likely related to effect of build up of material on the edge of the image area. There were minimal effects quantified for both the fountain solutions and blankets. The correlation with the profilometry results for the fountain solution is good, while there were clear differences seen for the blankets that were not detected by the operator. This is primarily due to the averaging of the different piling that was necessitated for the analysis and also the very low levels of piling that were detected.

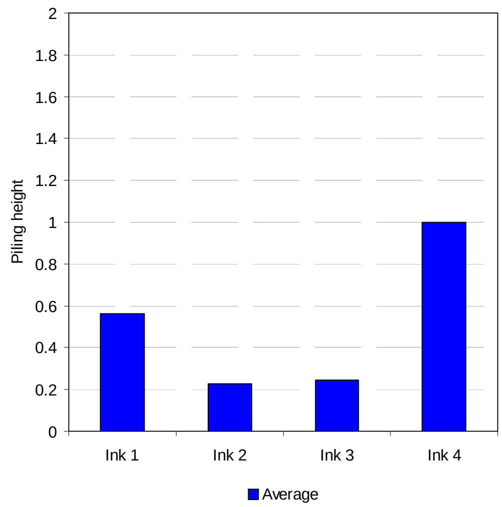

Figure 8: Manually assessed piling levels for ink for the black unit

The piling increased throughout the press and the largest piling levels were detected on the yellow units by both the profilometry and manual assessment of the piling. The impact of paper on the level of piling on the yellow unit is shown in Figure 9. The results are different from those obtained from the profilometry, for which the same trends that were evident on the black unit also occurred on the yellow unit, though to a much larger level and with an increasing amount of interactions. The piling on paper one was much larger than either of the other two papers. Papers two and three were a combination of the non image and low coverage piling, identified in the earlier publication. These resulted in an equal effect across the different areas on the blanket. The piling identified with paper one was much higher as there was the occurrence of *"worms"* on the edge of the paper, Figure 6. These *"worms"* were the build up of material on the edge of the print area and they would migrate around the circumference of the blanket. They were not detected with any of the profilometry measurements as they were outside the investigation area. The build up of material defined as *"worms"* were removed after selected trials and samples analyzed for their composition using EDS and FTIR analysis. The analysis of the samples indicated that these were a build-up of the paper coating and ink. In certain cases, there was also an indication that there was some of the base sheet included in the samples. The *"worms"* occurred to a greater extent with paper one and this resulted in the higher piling rating. The *"worm"* thickness was relatively large and could give rise to a smash of the blanket surface. In most cases the blankets were changed prior to cleaning. If the build-up was low, following cleaning of the blanket the surface was also checked and if there was any sign of a smash in the blanket it was changed. This result shows the importance of using multiple assessment techniques when assessing piling. The profilometry allows the detailed investigation of specific areas and types of piling that is occurring while the manual assessment allows global effects to be characterized and monitored.

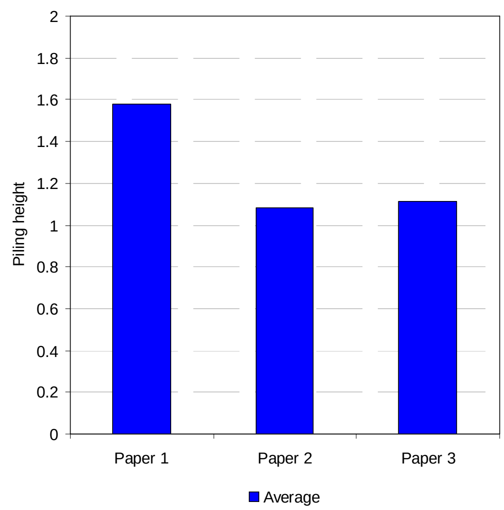

Figure 9: Manually assessed piling levels for paper for the yellow unit

The results from the piling assessment for the different inks on the yellow unit showed that the ink would affect the level of piling. The piling was in close agreement with the profilometry obtained from the header region of the image. This was where the more significant (area wise) piling was occurring on the blanket and this was also the area that was providing the most apparent problems with the print quality. The fountain solution showed a small impact of the level of the piling, while there were differences seen with the blankets, with blanket four having much higher levels. This was due primarily to a build-up of material on the edges of the blanket.

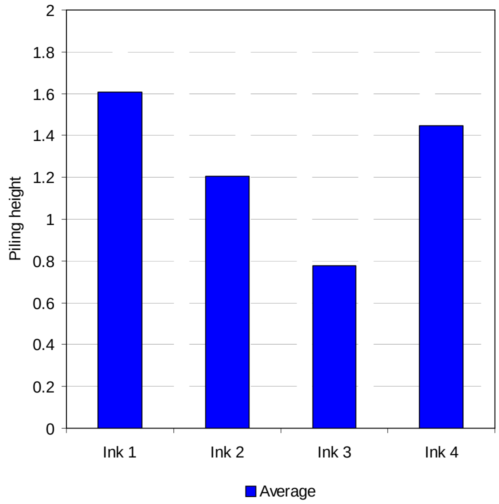

Figure 10: Manually assessed piling levels for ink for the yellow unit

Conclusions

An extensive press trial using in excess of fifty print runs to evaluate the effect of ink, blankets, paper and fountain solution on the propensity of a web offset printing press to produce piling has been successfully completed. This was carried out under controlled conditions and the piling has been quantified numerically using a profilometer, and also manually by an operator. There are many interactions occurring between the different parameters assessed and different forms of piling were evident throughout the different press runs. The results can be summarized as:

- Physical assessment of the blanket was difficult with low piling levels.
- Clear definitions of the assessment area are required with physical assessment; else the results will be skewed by large features on the blanket.
- The build-up of material was a combination of the paper coating and ink, with in certain cases some of the base sheet being observed.
- The type of piling was dependent on the combination of parameters used and the magnitude was dependent on the location.
- The introduction of low halftone coverage (compared to no coverage) will significantly affect the level of piling and the significant parameters.
- The interactions occurring showed that it was necessary to evaluate the whole press configuration and not just individual parameters.

- Paper would significantly affect the level of piling, though interactions could negate its impact.
- The ink will affect not only the magnitude but also the form of the piling.
- The blanket choice would give rise to different responses of the system to changes in the other variables.

References

1. Bohan, M.F.J. and Lind, J. "Quantification of piling", 57th TAGA Conference, 2005.

Acknowledgements

The authors would like to acknowledge the following companies for their help in the project, Flint Ink, Fuji Hunt, MacDermid Printing Solutions, MAN Roland, M-real Corporation, Reeves Brothers, Inc., Rycoline, Stora Enso, Sun Chemical, and UPM-Kymmene, Inc.

The authors would like to acknowledge the following PIA/GATF staff: Tom DeBaldo, John Morelli, and Greg Workman. Additional thanks to David Dezzutti, Brad Evans, Brian May, William McLauchlan, Rick Wagner, and Sara Welsh.